

XML Representations of Music

MusicXML/MEI

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XML history

- eXtensible Markup Language

Version 0 :: 1996
Version 1.0 :: 1998
Version 1.1 :: 2004
Version 1.1.5 :: 2008

<http://en.wikipedia.org/wiki/XML>

- Predecessor: SGML (Standardized Generalized Markup Language)

1970's – 1980's

http://en.wikipedia.org/wiki/Standard_Generalized_Markup_Language

HTML 1.0 1991
 2.0 1995
 4.0 1997
 5.0 2008

- Predecessor: GML (Generalize Markup Language)

1960's

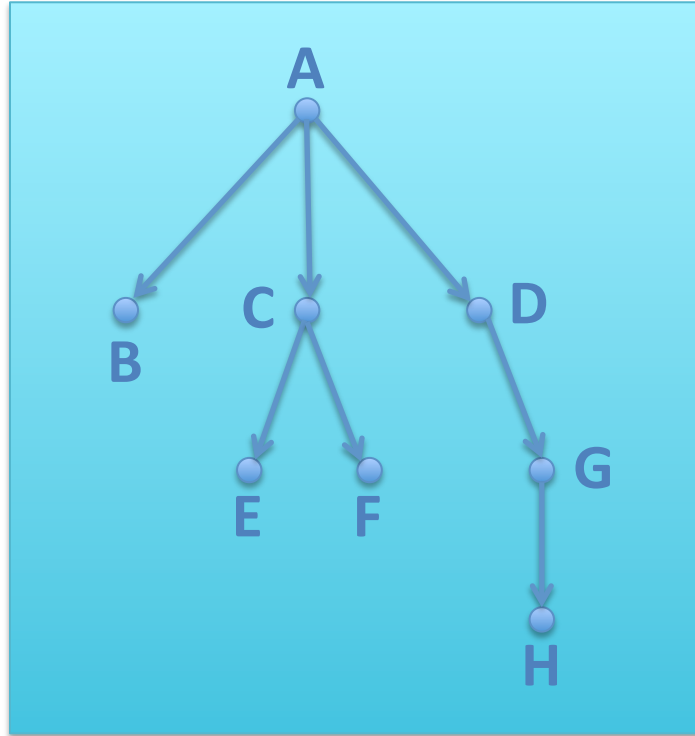
http://en.wikipedia.org/wiki/IBM_Generalized_Markup_Language

XML example

```
<root-node>  
  <key>Value</key>  
  <key value="2">  
    <another-key>  
      <subkey/>  
    </another-key>  
</root-node>
```

XML data structure

- XML describes a tree structure:



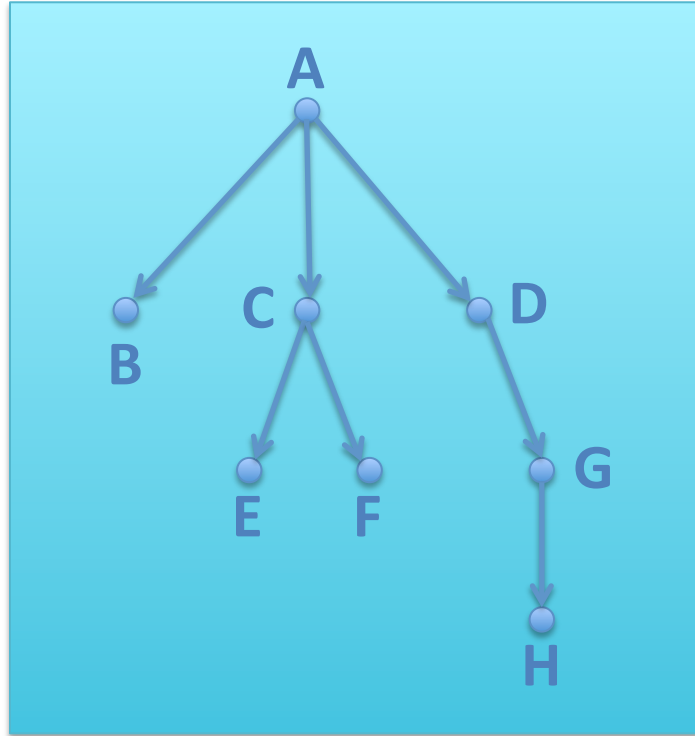
- Indented format:

```
<A>  
  <B/>  
  <C>  
    <E/>  
    <F/>  
  </C>  
  <D>  
    <G>  
      <H/>  
    </G>  
  </D>  
</A>
```

- Equivalent serialization: `<A><C><E/><F/></C><D><G><H/></G></D>`
(whitespace/newlines don't count)

XML data structure

- XML describes a tree structure:



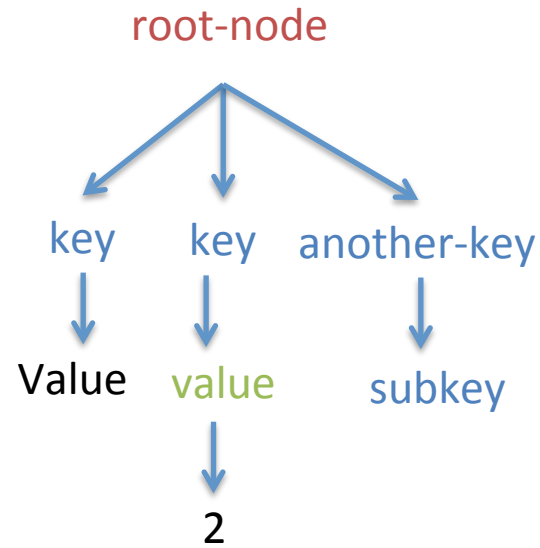
- Same data structure as directories/folders on a hard disk
- Same conceptualization as LISP code:

`(A B (C E F) (D (G (H))))`

Only one “root node” allowed in document

XML example

```
<root-node>  
  <key>Value</key>  
  <key value="2">  
    <another-key>  
      <subkey/>  
    </another-key>  
</root-node>
```



Root element
Element
Attribute
Text

XML Terminology

<A>

<C>

<E/>

<F/>

</C>

<D>

<G>

<H/>

</G>

</D>

- <C>...</C> is an **element** (tree node)
 - C is the element's **name**
 - <C> is a **start tag**
 - </C> is an end tag
 - <E/> and <F/> are **element content** of <C> or **child** nodes of <C>, and <C> is their **parent** node.
 - Plain text inside of an element is **text content**
-
- <H/> is an element without contents (terminal node)
 - <H/> is equivalent to <H></H>
 - Start tags *must* be followed by matching end tag, or the shorthand <xxx/> must be used.

Element Attributes

- Elements can contain a list of attributes within the start tag
- Like special-purpose child nodes

``

- Element **A** has three *attributes*: **a**, **b**, and **c**.
- A is the *name* of the attribute, 1 is its *value*.
- Attributes must have values. `c=""` represents an attribute with an empty value.
- Attributes are optional (similar to key values in LISP).
- The value of a is 1, the value of b is two and the value of c is 1 and 2.
- XML Attribute values *must* be enclosed in double or single quotes.
- Only one attribute of a given name allowed. Bad: ``
- Attributes are considered unordered:

`` is identical to ``

HTML attributes do not need to be enclosed in quotes:

`<table cellpadding=10>` is equivalent to `<table cellpadding="10">`

XHTML does not allow the first case since quotes are always needed.

Elements vs. Attributes

- Elements can contain sub-elements
- Attributes cannot contain sub-attributes
- Two similar (but not identical) ways of expressing the same data:

```
<A a="1" b="two" c="1 and 2"/>
```

```
<A>  
  <a>1</a>  
  <b>two</b>  
  <c>1 and 2</c>  
</A>
```

Informal shorthand for attribute **a** of element **A** (but not in data):

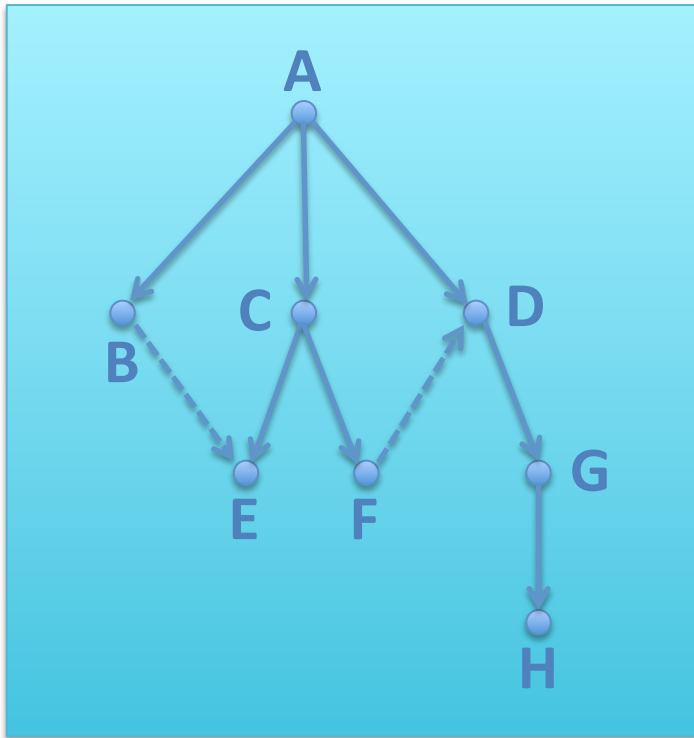
A@a

Difference between attributes and elements:

- **Attribute a** in the first example cannot be expanded later into sub-attributes
- **Element a** in the second example can be expanded later to include element contents

XML for non-tree structured data

- XML can only represent one tree hierarchy at a time.
- Non-tree data can be shoe-horned into XML data structure.



- Tree-like portions encoded as XML elements
- Non-tree connections handled by specialized id/idref/idrefs attributes.

```
<A>
  <B idref="e"/>
  <C>
    <E id="e"/>
    <F idref="d"/>
  </C>
  <D id="d">
    <G>
      <H/>
    </G>
  </D>
</A>
```

- Similar to pointers in C.

XML declaration

- Used to indicate that the following data is XML data
- First characters in file must be “<?xml” (see UTF-16 below).

<?xml version=“1.0” encoding=“UTF-8” standalone=“yes”?>

Three attributes which *must* be in this order (but optional):

@version = version of XML being used (1.0 or 1.1).

@encoding = character set being used in data. (also UTF-16 which requires two endian bytes before opening <?)

* UTF-8 is backwards compatible with 7-bit ASCII

* UTF-16 is not.

@standalone = “yes” if no external definition file, “no” if DTD (Document Type Definition) or Schema.

XML complete data file

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<A>
  <B idref="e"/>
  <C>
    <E id="e"/>
    <F idref="d"/>
  </C>
  <D id="d">
    <G>
      <H/>
    </G>
  </D>
</A>
```

Even more complete data file

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
```

```
<!DOCTYPE A [
```

```
  <!ELEMENT A (B,C,D)>
```

Element A can have subelements B, C & D.

```
  <!ELEMENT C (E,F)>
```

```
  <!ELEMENT D (G)>
```

```
  <!ELEMENT G (H)>
```

```
  <!ATTLIST B idref IDREF #IMPLIED>
```

Element B can have an attribute named idref which can be set to a value which is the type IDREF.

```
  <!ATTLIST E id ID #IMPLIED>
```

```
  <!ATTLIST D id ID #IMPLIED>
```

```
<A>
```

```
  <B idref="e"/>
```

```
  <C>
```

```
    <E id="e"/>
```

```
    <F idref="d"/>
```

```
  </C>
```

```
  <D id="d">
```

```
    <G>
```

```
      <H/>
```

```
    </G>
```


```
  </D>
```

```
</A>
```

DTD

Document Type Definition:
Describes how nodes in data can
be arranged.

Data/Structure definition separation

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!DOCTYPE A SYSTEM "tree.dtd">
or <!DOCTYPE A SYSTEM "http://somewhere.com/tree.dtd">
or <!DOCTYPE A PUBLIC "-//Owner/Class Description//Language//Version" "tree.dtd">
<A>  Formal Public Identifier
 <B idref="e"/>
 <C>
 <E id="e"/>
 <F idref="d"/>
 </C>
 <D id="d">
 <G>
 <H/>
 </G>
 </D>

Separate file called tree.dtd:

```
<!ELEMENT A (B,C,D)>  
<!ELEMENT C (E,F)>  
<!ELEMENT D (G)>  
<!ELEMENT G (H)>  
<!ATTLIST B idref IDREF #IMPLIED>  
<!ATTLIST E id ID #IMPLIED>  
<!ATTLIST D id ID #IMPLIED>
```

MusicXML

<https://www.musicxml.com>

<https://en.wikipedia.org/wiki/MusicXML>

- Created around 2000 by Michael Good
- v1.0 in 2004
- v2.0 in 2007
- v3.0 in 2011
- Structure primarily derived from MuseData (covered last week)
- Some influence from Humdrum (covered next week)
- Primary intent is for data interchange between notation programs (initially Finale and Sibelius)
- Currently owned by MakeMusic (developer of Finale)
- DTD, XSD (schema) <https://www.musicxml.com/for-developers>
- Element/Attribute docs: <http://usermanuals.musicxml.com/MusicXML/MusicXML.htm>

MusicXML

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE score-partwise PUBLIC "-//Recordare//DTD MusicXML 1.0 Partwise//EN"
"http://www.musicxml.org/dtds/1.0/partwise.dtd">
```

<score-partwise>

<identification>

<encoding>

<software>Finale 2012 for Mac</software>

<software>Dolet Light for Finale 2012</software>

<encoding-date>2013-01-21</encoding-date>

</encoding>

</identification>

<part-list>

<score-part id="P1">

<part-name>MusicXML Part</part-name>

<score-instrument id="P1-I1">

<instrument-name>Garritan: ARIA Player</instrument-name>

</score-instrument>

<midi-instrument id="P1-I1">

<midi-channel>1</midi-channel>

<midi-bank>15489</midi-bank>

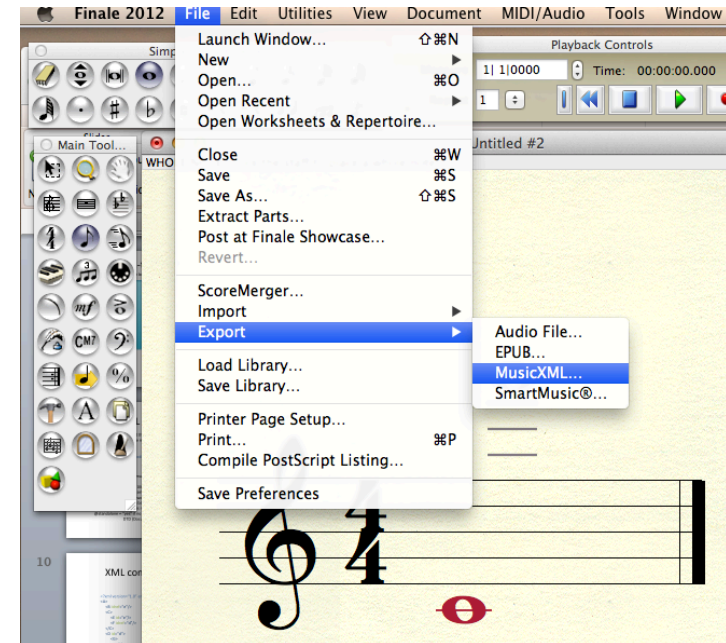
<midi-program>1</midi-program>

</midi-instrument>

</score-part>

</part-list>

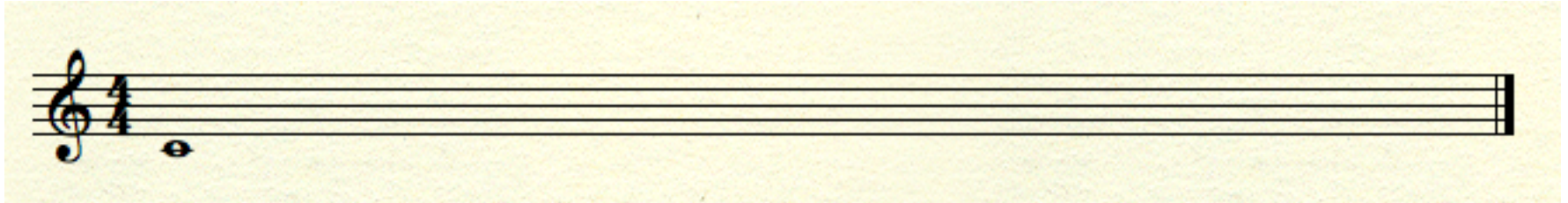
<!--=====-->



<!-- ... --> is a comment in XML

visual barline for readability

MusicXML (2)



```
<part id="P1">
  <measure number="1">
    <print/>
    <attributes>
      <divisions>2</divisions>
      <key>
        <fifths>0</fifths>
        <mode>major</mode>
      </key>
      <time>
        <beats>4</beats>
        <beat-type>4</beat-type>
      </time>
      <clef>
        <sign>G</sign>
        <line>2</line>
      </clef>
    </attributes>
    <sound tempo="120"/>
  </measure>
</part>
```

divisions per quarter note

```
<note default-x="86">
  <pitch>
    <step>C</step>
    <octave>4</octave>
  </pitch>
  <duration>8</duration>
  <voice>1</voice>
  <type>whole</type>
</note>
<barline location="right">
  <bar-style>light-heavy</bar-style>
</barline>
</measure>
</part>
<!--=====-->
</score-partwise>
```

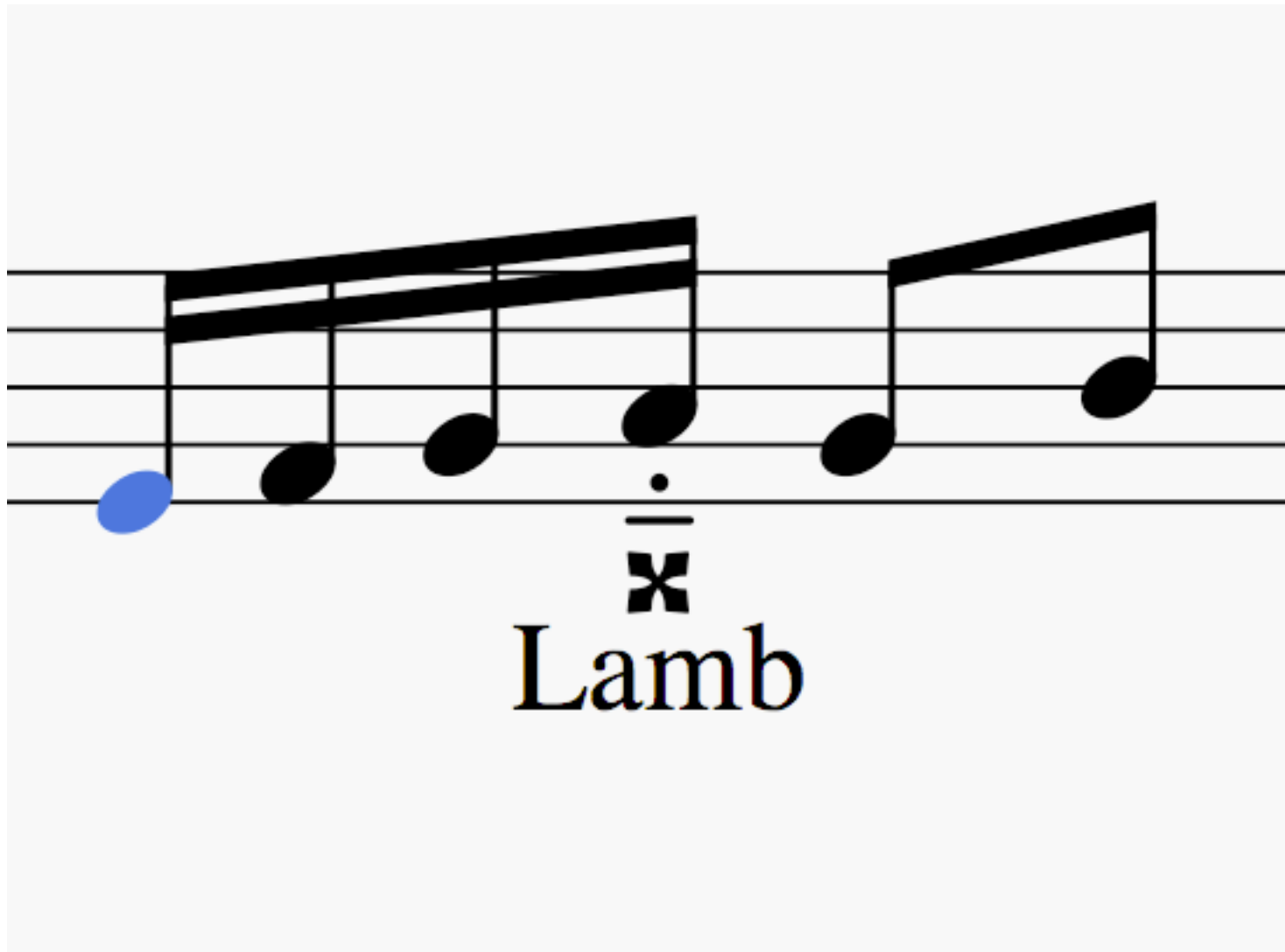
Compare to GUIDO (inScore):
[c/1]

Compare to
Humdrum:
**kern
*M4/4
1c
==
*_

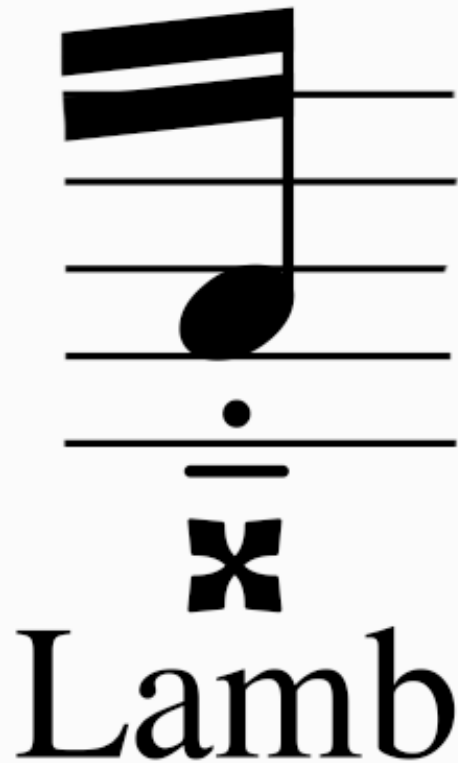
4 quarter notes

looks like a whole note

Data Interchange



MusicXML Note parameters



```
<note default-x="165.98" default-y="-25.00">  
  <pitch>  
    <step>A</step>  
    <alter>2</alter>  
    <octave>4</octave>  
  </pitch>  
  <duration>1</duration>  
  <voice>1</voice>  
  <type>16th</type>  
  <accidental>double-sharp</accidental>  
  <stem>up</stem>  
  <beam number="1">end</beam>  
  <beam number="2">end</beam>  
  <notations>  
    <articulations>  
      <detached-legato/>  
    </articulations>  
  </notations>  
  <lyric number="1">  
    <syllabic>single</syllabic>  
    <text>Lamb</text>  
  </lyric>  
</note>
```



Lamb

MuseScore



Finale

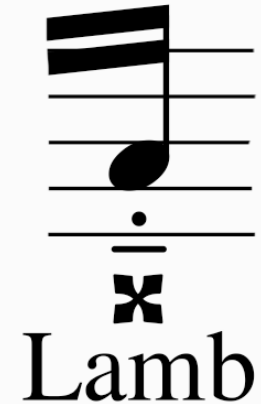
MuseScore to Finale

```
<note default-x="165.98" default-y="-25.00">
  <pitch>
    <step>A</step>
    <alter>2</alter>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>16th</type>
  <accidental>double-sharp</accidental>
  <stem>up</stem>
  <beam number="1">end</beam>
  <beam number="2">end</beam>
  <notations>
    <articulations>
      <detached-legato/>
    </articulations>
  </notations>
  <lyric number="1">
    <syllabic>single</syllabic>
    <text>Lamb</text>
  </lyric>
</note>
```

Output from MuseScore

```
<note default-x="180">
  <pitch>
    <step>A</step>
    <alter>2</alter>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>16th</type>
  <accidental>double-sharp</accidental>
  <stem default-y="10">up</stem>
  <beam number="1">end</beam>
  <beam number="2">end</beam>
  <notations>
    <articulations>
      <detached-legato default-x="1" default-y="-44" placement="below"/>
    </articulations>
  </notations>
  <lyric default-y="-80" number="1">
    <syllabic>single</syllabic>
    <text font-family="FreeSerif" font-size="10.8">Lamb</text>
  </lyric>
</note>
```

Output from Finale



MEI

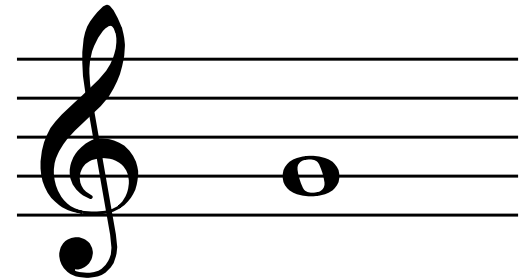
<http://www.music-encoding.org>

https://en.wikipedia.org/wiki/Music_Encoding_Initiative

- Created around 2000 by Perry Roland (University of Virginia)
- Structure primarily derived from TEI (Text Encoding Initiative)
- Some influence from Humdrum (covered next week)
- Primary intent is for digital critical (scholarly) editions
- Focus on modern notation, mensural notation, and chant notation
- Currently managed by MEI Board (hosted by the Academy of Sciences and Literature, Mainz, Germany)
<http://www.akademienunion.de/en/adw-mainz>
- Hosts annual conference (Music Encoding Conference)
This year in Tours, France
- Schema (no DTD): <https://github.com/music-encoding/music-encoding>
- Element/Attribute docs: <http://music-encoding.org/documentation/3.0.0/elements>

MEI example

Hello World!



```
<mei version="1.7b">
  <meihead>
    <meiid>20071029101306082</meiid>
    <filedesc>
      <titlestmt>
        <title>Hello World!</title>
      </titlestmt>
      <pubstmt/>
    </filedesc>
  </meihead>
  <work>
    <music>
      <mdiv>
        <score>
          <scoredef meter.count="4" meter.unit="4" key.sig="0">
            <staffgrp>
              <staffdef n="1" id="P1" label.full="Music" clef.line="2" clef.shape="G" midi.div="1" key.sig="0">
                </staffdef>
              </staffgrp>
            </scoredef>
            <section>
              <scoredef meter.count="4" meter.unit="4" key.sig="0"/>
              <measure n="1" id="d1e6">
                <staff>
                  <layer>
                    <note id="d1e24" tstamp="0" pname="c" oct="4" dur="1" dur.ges="4"/>
                  </layer>
                </staff>
              </measure>
            </section>
          </score>
        </mdiv>
      </music>
    </work>
  </mei>
```

Utilizes attributes more than MusicXML
(so looks more condensed)

Hierarchy used more than MusicXML

Heavy use of IDs (none/little in MusicXML)

TEI

- MEI is modeled after the Text Encoding Initiative: <http://www.tei-c.org/index.xml>
“a consortium which collectively develops and maintains a standard
for the representation of texts in digital form.”

```
<TEI xmlns='http://www.tei-c.org/ns/1.0' xmlns:xml='http://www.w3.org/XML/1998 namespace'
xml:id="A050153">
<teiHeader>
<fileDesc>
<titleStmt>
<title level="s">Aktuelle Nachrichten der Carl-Maria von Weber-Gesamtausgabe</title> <title
level="a">Quellcode von weber-gesamtausgabe.de auf GitHub verfügbar</title> <author
key="A009001">Peter Stadler</author>
</titleStmt> <publicationStmt>
<date when="2013-02-06T12:02:00"/>
</publicationStmt> <sourceDesc>
<p>born digital</p>
</sourceDesc>
</fileDesc> <profileDesc>
<textClass>
<keywords scheme="WeGA_cat">
<term>announcement</term>
</keywords>
</textClass>
</profileDesc>
</teiHeader> <text type="news">
<body>
<div xmlns:xml='http://www.w3.org/XML/1998/namespace' xml:lang="de">
<p>
Der Quellcode der Webapplikation weber-gesamtausgabe.de ist nun (endlich) unter <ref
target="https://github.com/Edirom/WeGA-WebApp">https://github.com/Edirom/WeGA-
WebApp</ref> frei verfügbar gemacht worden. <rs type="news" key="A050256">Vor ein paar
Wochen wurden bereits die XML-Schemata veröffentlicht</rs>, so dass gewissermaßen das
technische Fundament der Digitalen Weber-Edition jetzt auch offiziell frei zugänglich ist. Das
Ganze ist zwar auf unsere Ausgabe maßgeschneidert, ich hoffe aber doch, dass es zumindest als
Anhaltspunkt und Diskussionsgrundlage für ähnliche Editionsprojekte dienen mag.
</p> <p>Ein paar weiterführende Informationen finden sich auf den genannten Seiten, wobei die
Dokumentation des Ganzen noch ein großes Desperat ist. Ich freue mich über alle Fragen und
Kommentare und stehe auch bei einer geplanten Nachnutzung gerne mit Rat und Tat zur Seite!</
p>
</div>
</body>
</text>
</TEI>
```



rendering

Quellcode von weber-gesamtausgabe.de auf GitHub verfügbar

Der Quellcode der Webapplikation weber-gesamtausgabe.de ist nun (endlich) unter <https://github.com/Edirom/WeGA-WebApp> frei verfügbar gemacht worden. Vor ein paar Wochen wurden bereits die XML-Schemata veröffentlicht, so dass gewissermaßen das technische Fundament der Digitalen Weber-Edition jetzt auch offiziell frei zugänglich ist. Das Ganze ist zwar auf unsere Ausgabe maßgeschneidert, ich hoffe aber doch, dass es zumindest als Anhaltspunkt und Diskussionsgrundlage für ähnliche Editionsprojekte dienen mag.

Ein paar weiterführende Informationen finden sich auf den genannten Seiten, wobei die Dokumentation des Ganzen noch ein großes Desperat ist. Ich freue mich über alle Fragen und Kommentare und stehe auch bei einer geplanten Nachnutzung gerne mit Rat und Tat zur Seite!

Peter Stadler, Wednesday, February 6, 2013

- HTML on steroids
- Database format which can be transformed into HTML

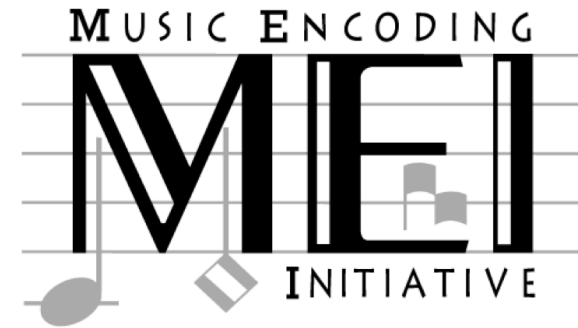
<http://www.weber-gesamtausgabe.de/en/A009001/News/A050153>

Formal Description/Documentation

<http://music-encoding.org/support/guidelines>

Currently three components:

- mei-CMN (Common western Music Notation)
- mei-Mensural (precursor to CMN)
- mei-Neumes (precursor to mensural notation)



- Element Tag Documentation:

<http://music-encoding.org/documentation/3.0.0/chapters>

<http://music-encoding.org/documentation/3.0.0/elements>



DTD/Schema/RelaxNG/ODD

- Method to verify structure of XML and, to some degree, content

DTD: http://en.wikipedia.org/wiki/Document_Type_Definition
http://www.w3schools.com/dtd/dtd_intro.asp

- Original method for formal description of XML file structure (XML 1.0).

Schema: [http://en.wikipedia.org/wiki/XML_Schema_\(W3C\)](http://en.wikipedia.org/wiki/XML_Schema_(W3C))

- 2001: Schema is also in XML format, a successor of DTDs
- XSD (XML Schema Definition)
- More data typing than DTDs
- Namespaces, such as “xml:id”

RelaxNG: http://en.wikipedia.org/wiki/RELAX_NG



- REgular LAnguage for Xml Next Generation
- 2009

ODD: TEI's meta representation to automatically generate Schema or RelaxNG format description.

Documentation

<http://music-encoding.org/documentation/3.0.0/chapters>

<http://music-encoding.org/documentation/3.0.0/elements>

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<note>

<note> A single pitched event.

Module	MEI.shared
Attributes	<p>@accid (optional) Captures a written accidental. Value conforms to data.ACCIDENTAL_EXPLICIT . (→ att.accidental)</p> <p>@accid.ges (optional) Records the performed pitch inflection. Value conforms to data.ACCIDENTAL_IMPLICIT . (→ att.accidental.performed)</p> <p>@altsym (optional) Provides a way of pointing to a user-defined symbol. It must contain an ID of a <symbolDef> element elsewhere in the document. Value conforms to data.URI . (→ att.altsym)</p> <p>@artic (optional) Encodes the written articulation(s). Articulations are normally encoded in order from the note head outward; that is, away from the stem. See additional notes at att.vis.note. Only articulations should be encoded in the artic attribute; for example, fingerings should be encoded using the <fingering> element. One or more values from data.ARTICULATION , separated by spaces. (→ att.articulation)</p> <p>@artic.ges (optional) Records performed articulation that differs from the written value. One or more values from data.ARTICULATION , separated by spaces. (→ att.articulation.performed)</p> <p>@beam (optional) Indicates that this event is "under a beam". One or more values from data.BEAM , separated by spaces. (→ att.beamed)</p> <p>@breaksec (optional) Presence of this attribute indicates that the secondary beam should be broken following this note/chord. The value of the attribute records the number of beams which should remain unbroken. Value of datatype positiveInteger. (→</p>

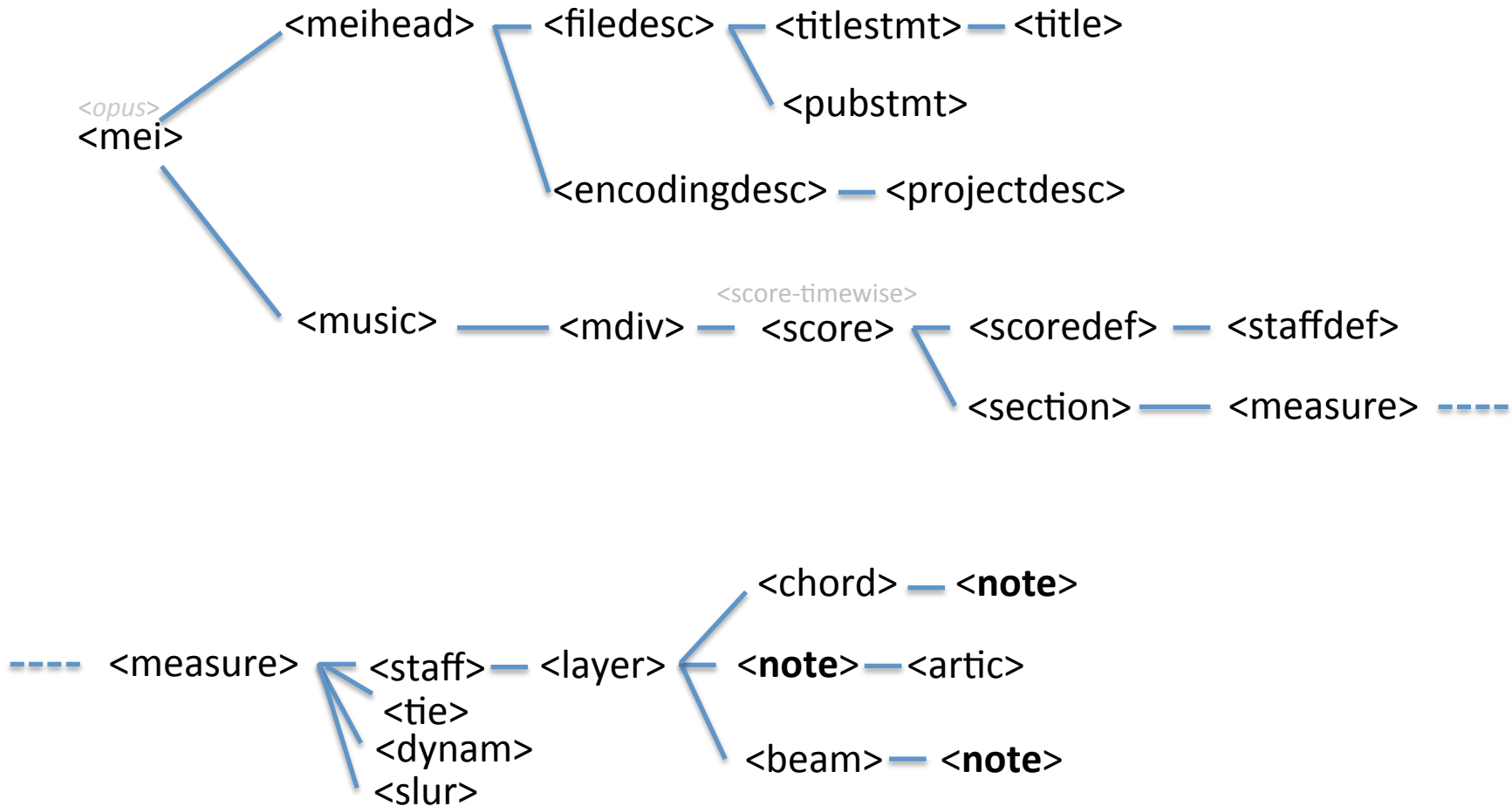
MEI Guidelines Version 3.0.0

[MEI Guidelines](#)
[Elements](#)
[Attributes](#)
[Model Classes](#)
[Data Types](#)

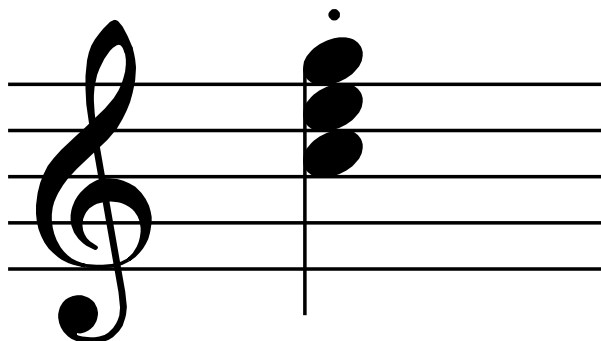
MEI Elements

[<abbr>](#)
[<accessRestrict>](#)
[<accid>](#)
[<actor>](#)
[<add>](#)
[<addName>](#)
[<addrlLine>](#)
[<address>](#)
[<altid>](#)
[<anchoredText>](#)
[<annot>](#)
[<app>](#)
[<appInfo>](#)
[<application>](#)
[<arpeg>](#)
[<arranger>](#)
[<artic>](#)
[<audience>](#)
[<author>](#)
[<avFile>](#)

Basic tree structure of MEI



Chords



MEI

```
<chord xml:id="d11e1" dur="4" dur.ges="1" stem.dir="down">
  <artic value="stacc"/>
  <note xml:id="d1e85" pname="g" oct="5"/>
  <note xml:id="d1e102" pname="e" oct="5"/>
  <note xml:id="d1e118" pname="c" oct="5"/>
</chord>
```

MuseData

G5	1	1	q	d	.
E5	1	1	q	d	
C5	1	1	q	d	

MusicXML

```
<note default-x="84">
  <pitch>
    <step>C</step>
    <octave>5</octave>
  </pitch>
  <duration>2</duration>
  <voice>1</voice>
  <type>quarter</type>
  <stem default-y="-50.5">down</stem>
  <notations>
    <articulations>
      <staccato default-x="3" default-y="15" placement="above"/>
    </articulations>
  </notations>
</note>
<note default-x="84">
  <chord/>
  <pitch>
    <step>E</step>
    <octave>5</octave>
  </pitch>
  <duration>2</duration>
  <voice>1</voice>
  <type>quarter</type>
  <stem>down</stem>
</note>
<note default-x="84">
  <chord/>
  <pitch>
    <step>G</step>
    <octave>5</octave>
  </pitch>
  <duration>2</duration>
  <voice>1</voice>
  <type>quarter</type>
  <stem>down</stem>
</note>
```

Beams



MEI

```
<note xml:id="n_sc_14_0" pname="b" oct="3" dur="4"/>
<beam>
  <note xml:id="n_sc_15_0" pname="c" oct="4" dur="8"/>
  <note xml:id="n_sc_16_0" pname="b" oct="3" dur="8"/>
</beam>
<note xml:id="n_sc_17_0" pname="a" oct="3" dur="4"/>
```

MuseData

B3	2	1	q	d	
C4	1	1	e	d	[
B3	1	1	e	d]
A3	2	1	q	d	

MusicXML

```
<note>
  <pitch>
    <step>B</step>
    <octave>3</octave>
  </pitch>
  <duration>2</duration>
  <voice>1</voice>
  <type>quarter</type>
  <stem>down</stem>
</note>
<note>
  <pitch>
    <step>C</step>
    <octave>4</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>eighth</type>
  <stem>down</stem>
  <beam number="1">begin</beam>
</note>
<note>
  <pitch>
    <step>B</step>
    <octave>3</octave>
  </pitch>
  <duration>1</duration>
  <voice>1</voice>
  <type>eighth</type>
  <stem>down</stem>
  <beam number="1">end</beam>
</note>
<note>
  <pitch>
    <step>A</step>
    <octave>3</octave>
  </pitch>
  <duration>2</duration>
  <voice>1</voice>
  <type>quarter</type>
  <stem>down</stem>
</note>
```

MEI data on the web

<http://music-encoding.org/downloads/encodings>

<https://github.com/music-encoding/sample-encodings>

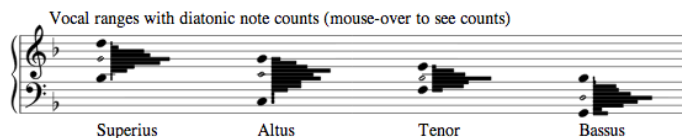
The screenshot shows the website music-encoding.org/documentation/samples. The page features a navigation bar with links: About MEI, Documentation, Downloads, Support, Activities, Conference, and Archive. On the left, a sidebar contains links for MEI2013, Sample Encodings (highlighted), and MEI Search. The main content area displays a table of sample encodings.

Title	Composer	Version	Link
Walzer G-Dur	Dionisio Aguado y García	MEI2012	XML DC PDF
Jesu, meines Herzens Freud	Johann Rudolf Ahle	MEI2012	XML DC PDF
Concerto à 7 Trompeten und Pauken aus "Versuch einer Anleitung zur heroisch-musikalischen Trompeter - und Pauker - Kunst"	Johann Ernst Altenburg	MEI2012	XML DC PDF
Ein feste Burg ist unser Gott	Michael Altenburg	MEI2012	XML DC PDF
Macht auf die Tor der Gerechtigkeit	Michael Altenburg	MEI2012	XML DC PDF
Tuplets		MEI2013	XML DC PDF
Tuplet II		MEI2013	XML DC PDF
chord-artic		MEI2013	XML DC PDF
Example of encoding using copyof attribute	Gabriel Fauré	MEI2013	XML DC PDF
Example of encoding syllables as attributes	Ludwig van Beethoven	MEI2013	XML DC PDF
Fughette	Johann Christoph Bach	MEI2012	XML DC PDF
Fughette	Johann Christoph Bach	MEI2012	XML DC PDF
4. Brandenburgisches Konzert in G-Dur	Johann Sebastian Bach	MEI2012	XML DC PDF
4. Brandenburgisches Konzert in G-Dur	Johann Sebastian Bach	MEI2012	XML DC PDF
Ein feste Burg ist unser Gott	Johann Sebastian Bach	MEI2012	XML DC PDF
Herzliebster Jesu, was hast du verbrochen	Johann Sebastian Bach	MEI2012	XML DC PDF

MEI data on the web

<http://jrp.ccarh.org>

- JRP: database of music from the early Renaissance (1420-1520)
- Data available in Humdrum (primary format), MIDI, MuseData, MusicXML and MEI.
- Primarily Josquin des Prez
- Currently 1,000,000+ notes/1,000 works



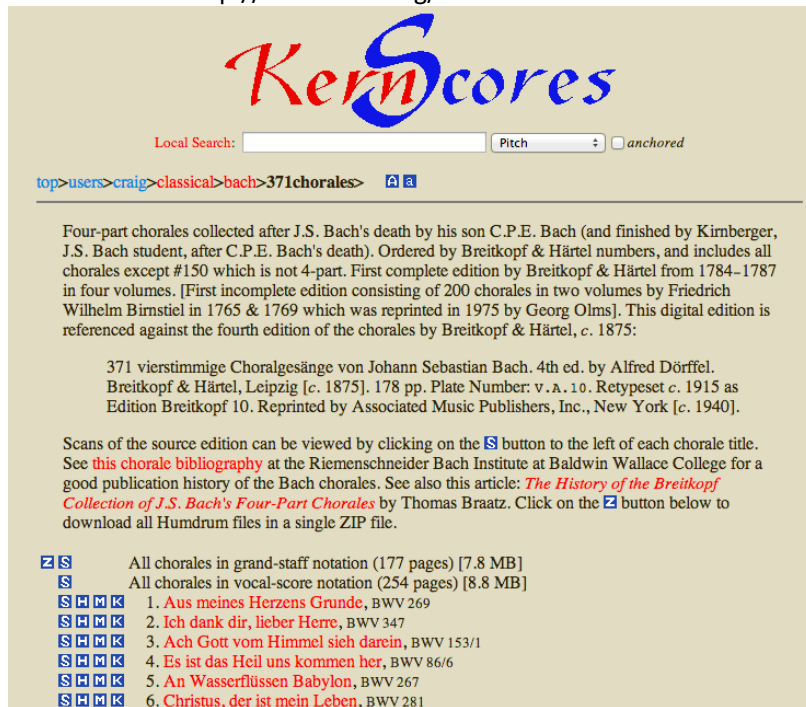
Data formats:

- | | | |
|---------------------|----------------------|---------------|
| PDF score | Humdrum file (plain) | MusicXML file |
| Score with ed. acc. | MuseData file | MEI file |
| MIDI file | NoteArray file | |

```
<measure n="1" xml:id="mx_sc_1">
  <staff n="1">
    <layer n="1">
      <rest xml:id="n_sc_29_3" dur="breve" dots="1"/>
    </layer>
  </staff>
  <staff n="2">
    <layer n="1">
      <note xml:id="n_sc_29_2" pname="g" oct="3" dur="breve"/>
    </layer>
  </staff>
  <staff n="3">
    <layer n="1">
      <rest xml:id="n_sc_29_1" dur="breve" dots="1"/>
    </layer>
  </staff>
  <staff n="4">
    <layer n="1">
      <rest xml:id="n_sc_29_0" dur="breve" dots="1"/>
    </layer>
  </staff>
</measure>
```

MEI data on the web (2)

<http://kern.ccarh.org/browse?l=371chorales>



KernScores

Local Search: Pitch ☐ anchored

[top](#) > [users](#) > [craig](#) > [classical](#) > [bach](#) > **371chorales** [\[i\]](#) [\[e\]](#)

Four-part chorales collected after J.S. Bach's death by his son C.P.E. Bach (and finished by Kimberger, J.S. Bach student, after C.P.E. Bach's death). Ordered by Breitkopf & Härtel numbers, and includes all chorales except #150 which is not 4-part. First complete edition by Breitkopf & Härtel from 1784–1787 in four volumes. [First incomplete edition consisting of 200 chorales in two volumes by Friedrich Wilhelm Birnstiel in 1765 & 1769 which was reprinted in 1975 by Georg Olms]. This digital edition is referenced against the fourth edition of the chorales by Breitkopf & Härtel, c. 1875:

371 vierstimmige Choralgesänge von Johann Sebastian Bach. 4th ed. by Alfred Dörffel. Breitkopf & Härtel, Leipzig [c. 1875]. 178 pp. Plate Number: v. A. 10. Retypeset c. 1915 as Edition Breitkopf 10. Reprinted by Associated Music Publishers, Inc., New York [c. 1940].

Scans of the source edition can be viewed by clicking on the [\[S\]](#) button to the left of each chorale title. See [this chorale bibliography](#) at the Riemenschneider Bach Institute at Baldwin Wallace College for a good publication history of the Bach chorales. See also this article: [The History of the Breitkopf Collection of J.S. Bach's Four-Part Chorales](#) by Thomas Braatz. Click on the [\[Z\]](#) button below to download all Humdrum files in a single ZIP file.

[\[Z\]](#) [\[S\]](#) All chorales in grand-staff notation (177 pages) [7.8 MB]
[\[S\]](#) All chorales in vocal-score notation (254 pages) [8.8 MB]
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 1. Aus meines Herzens Grunde, BWV 269
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 2. Ich dank dir, lieber Herre, BWV 347
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 3. Ach Gott vom Himmel sieh darein, BWV 153/1
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 4. Es ist das Heil uns kommen her, BWV 86/6
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 5. An Wasserflüssen Babylon, BWV 267
[\[S\]](#) [\[H\]](#) [\[M\]](#) [\[K\]](#) 6. Christus, der ist mein Leben, BWV 281

<http://kern.ccarh.org/data?file=chor001.krn&l=371chorales&format=info>



KernScores

1. Aus meines Herzens Grunde, BWV 269

Location	top > users > craig > classical > bach > 371chorales
Humdrum file	chor001.krn [i] [expanded repeats] [no repeats] [e]
Composer	Bach, Johann Sebastian
Composer's dates	21 Feb 1685 - 28 Jul 1750
Title: orig. lang.:	Aus meines Herzens Grunde
German	
Title: English	From the Depths of My Heart
Data Format	PDF Score: chor001.pdf
Translations	Standard MIDI File: chor001.mid [without repeats]
Director Musices:	chor001.mus
Melisma Format:	chor001.notes
MusicXML:	chor001.xml
STK/SKIN:	chor001.ski
Guido:	chor001.gmn [notation via noteserver.org]
ABC+:	chor001.abc [notation via abcm2ps] [number every bar]
MuseData:	chor001.mid2 [notation via muse2ps]
SA Sonorities:	chor001.dat
MEI:	chor001.mei

<http://kern.ccarh.org/sdata?l=371chorales&file=chor001.krn&f=mei>

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<?oxygen SCHSchema="http://music-encoding.org/mei/schemata/2010-05/rng/mei-all.rng"?>
<?oxygen RNGSchema="http://music-encoding.org/mei/schemata/2010-05/rng/mei-all.rng"
  type="xml"?>
<mei xmlns:xlink="http://www.w3.org/1999/xlink" xmlns="http://www.music-encoding.org/ns/
  mei" meiversion="2010-05">
  <meihead>
    <filedesc>
      <titlemt>
        <title type="main" xml:lang="ger">Aus meines Herzens Grunde</title>
        <title type="translated" xml:lang="eng">From the Depths of My Heart</title>
      </titlemt>
      <pubstmt/>
    </filedesc>
    <profiledesc>
      <language>
        <language xml:id="eng" authority="iso639-2"/><!-- English -->
        <language xml:id="ger" authority="iso639-2"/><!-- German -->
      </language>
    </profiledesc>
  </meihead>
  <music>
    <body>
      <mdiv>
        <score>
          <scoredef key.sig="1s" key.pname="g" key.accid="n" key.mode="major" meter.count="3"
            meter.unit="4">
            <staffgrp>
              <staffdef n="1" clef.shape="G" clef.line="2"/>
              <staffdef n="2" clef.shape="G" clef.line="2"/>
              <staffdef n="3" clef.shape="G" clef.line="2" clef.trans="8vb"/>
              <staffdef n="4" clef.shape="F" clef.line="4"/>
            </staffgrp>
            <!-- <secexpan repeat="true" label="default" ids="A A B"/> -->
            <!-- <secexpan repeat="false" label="norep" ids="A B"/> -->
          </scoredef>
          <section xml:id="A">
            <measure xml:id="mx_sc_13">
              <staff n="1">
                <layer n="1">
                  <note xml:id="n_sc_19_3" pname="g" oct="4" dur="4"/>
                </layer>
              </staff>
              <staff n="2">
                <layer n="1">
                  <note xml:id="n_sc_19_2" pname="d" oct="4" dur="4"/>
                </layer>
              </staff>
              <staff n="3">
                <layer n="1">
                  <note xml:id="n_sc_19_1" pname="b" oct="3" dur="4"/>
                </layer>
              </staff>
```


The Music Encoding Conference 2015

18-21 May, 2015

Florence, Italy

Music encoding is now a prominent feature of various areas in musicology and music librarianship. The encoding of symbolic music data provides a foundation for a wide range of scholarship, and over the last several years, has garnered a great deal of attention in the digital humanities. This conference intends to provide an overview of the current state of data modeling, generation, and use, and aims to introduce new perspectives on topics in the fields of traditional and computational musicology, music librarianship, and scholarly editing, as well as in the broader area of digital humanities.

This conference aims to gather specialists in all the above areas, to discuss the current state of modeling, generation and use of music encoding, to exchange experiences, report on successful projects on major collections and composers, and to forge collaborations for future projects.

The program opens on Monday, May 18th with a pre-conference day devoted to workshops/tutorials on MEI and its application to scholarly publication, followed by two days of papers and poster presentations covering various theoretical and practical issues in research and publishing. The program is completed by an "Unconference Day" on Thursday, May 21: an opportunity for everyone interested in using and improving MEI — developers, librarians, musicologists, editors, publishers — to investigate the topics they're most interested in.

Verovio

<http://www.verovio.org>

Leipzig



Bravura



Gootville



SCORE



<http://rism-ch.github.io/verovio/smufl.xhtml>

Wolfgang

Wolfgang est développé dans le cadre de l'Université de Genève par Etienne Darbellay, musicologue et informaticien.



Largo

Violino Primo

Violino Secondo

Basso

P

F

6 4 5 3 6 4 5 3 6 4 5 3 6 4 5 3

A musical score for a piece titled 'Wolfgang', marked 'Largo'. It consists of a single system with three staves: Violino Primo, Violino Secondo, and Basso. The music is written in a key with two flats (B-flat and E-flat) and a common time signature (C). The notation includes various note values, rests, and some accidentals. There are also some performance markings like 'P' and 'F'.

Wolfgang supporte désormais l'importation de fichiers au format GUIDO. Cette fonction permet l'échange avec d'autres applications (logiciels de reconnaissance de musique ou autres logiciels d'édition).

Verovio (2)

Verovio (mostly) preserves the MEI structure in SVG rendering

MEI

```
<tuplet xml:id="t1" num="3" numbase="2">
  <beam xml:id="b1">
    <note xml:id="n1" pname="d" oct="5" dur="8" />
    <note xml:id="n2" pname="e" oct="5" dur="16" dots="1" />
    <note xml:id="n3" pname="d" oct="5" dur="32" />
    <note xml:id="n4" pname="c" oct="5" dur="8" accid="s" />
  </beam>
</tuplet>
<beam xml:id="b2">
  <tuplet xml:id="t2" num="3" numbase="2">
    <note xml:id="n5" pname="d" oct="5" dur="8" />
    <note xml:id="n6" pname="e" oct="5" dur="16" dots="1" />
    <note xml:id="n7" pname="f" oct="5" dur="32" accid="s" />
    <note xml:id="n8" pname="e" oct="5" dur="8" />
  </tuplet>
</beam>
```

SVG

```
<g class="tuplet" id="svg-t1" >
  <g class="beam" id="svg-b1" >
    <g class="note" id="svg-n1" >...</g>
    <g class="note" id="svg-n2" >...</g>
    <g class="note" id="svg-n3" >...</g>
    <g class="note" id="svg-n4" >...</g>
  </g>
</g>
<g class="beam" id="svg-b2" >
  <g class="tuplet" id="svg-t2" >
    <g class="note" id="svg-n5" >...</g>
    <g class="note" id="svg-n6" >...</g>
    <g class="note" id="svg-n7" >...</g>
    <g class="note" id="svg-n8" >...</g>
  </g>
</g>
```

Former Leipzig
treble clef



Verovio (3)

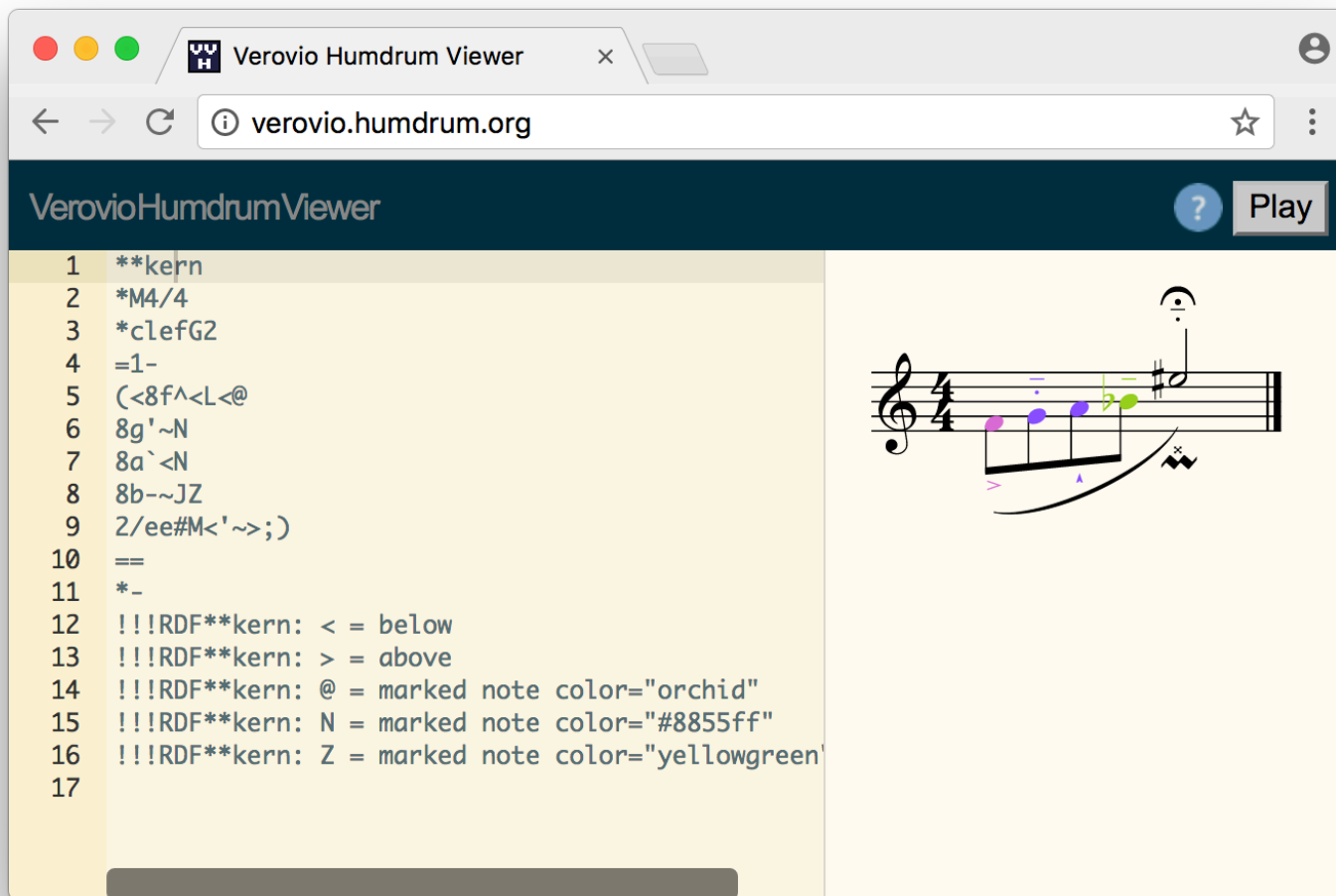
RISM / Plaine & Easie code



```
@clef:C-4  
@keysig:xFC  
@timesig:c/  
@data:,{8.A6A}/'4.Dt8D4.Ct8D/{8.E6C},8(A)'E4DtE/{8.Ft3GE}8(D)-2-/
```


Verovio Humdrum Viewer

- Front-end for Humdrum data viewing/editing
- Back-end is MEI/Verovio

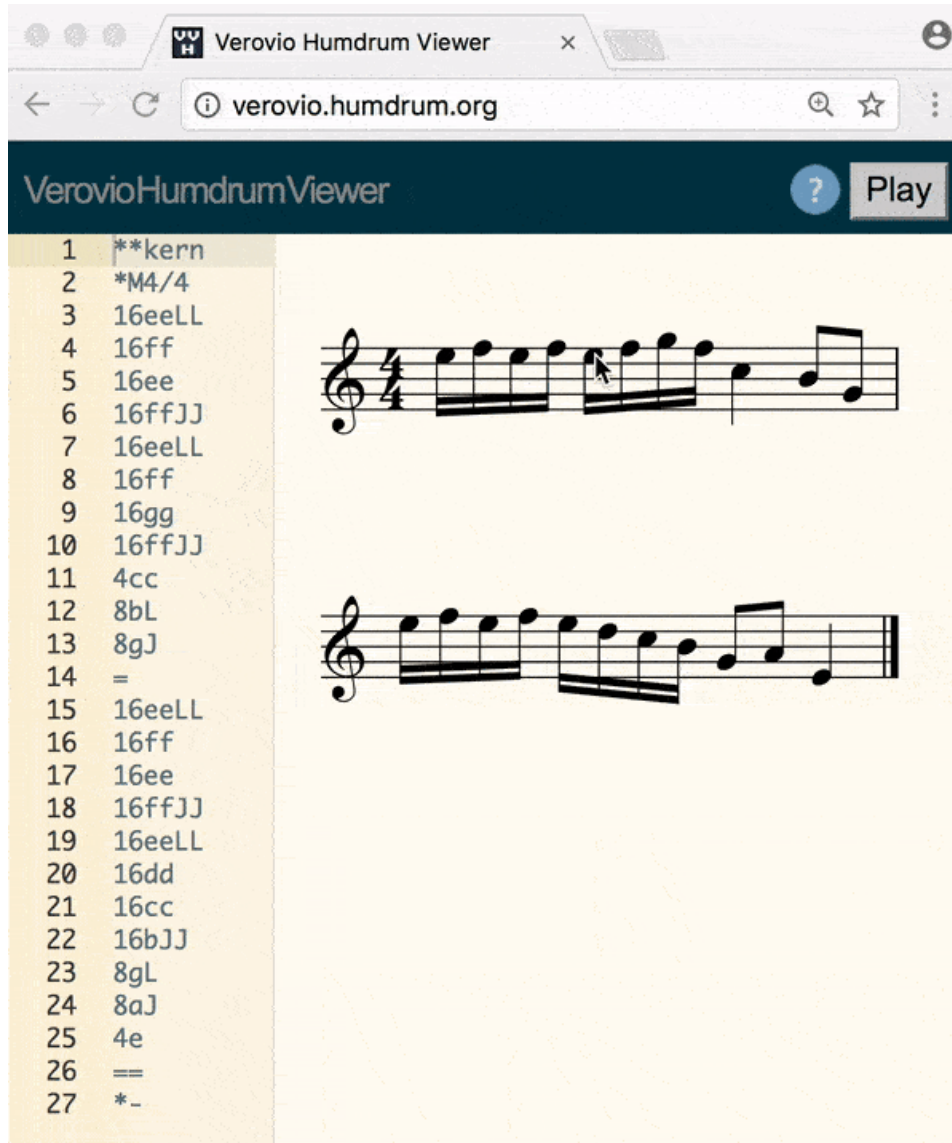


The screenshot shows a web browser window with the title "Verovio Humdrum Viewer" and the address bar displaying "verovio.humdrum.org". The page has a dark blue header with the text "VerovioHumdrumViewer" and a "Play" button. The main content area is split into two panels. The left panel displays a Humdrum file with 17 lines of text, including musical notation and comments. The right panel shows the corresponding musical notation in 4/4 time, featuring a treble clef, a key signature of one sharp (F#), and a melody with notes marked with various symbols and colors.

```
1  **kern
2  *M4/4
3  *clefG2
4  =1-
5  (<8f^<L<@
6  8g'~N
7  8a`<N
8  8b-~JZ
9  Z/ee#M<'~>;)
10 ==
11 *-
12 !!!RDF**kern: < = below
13 !!!RDF**kern: > = above
14 !!!RDF**kern: @ = marked note color="orchid"
15 !!!RDF**kern: N = marked note color="#8855ff"
16 !!!RDF**kern: Z = marked note color="yellowgreen"
17
```



Graphical Editing: add/move slur



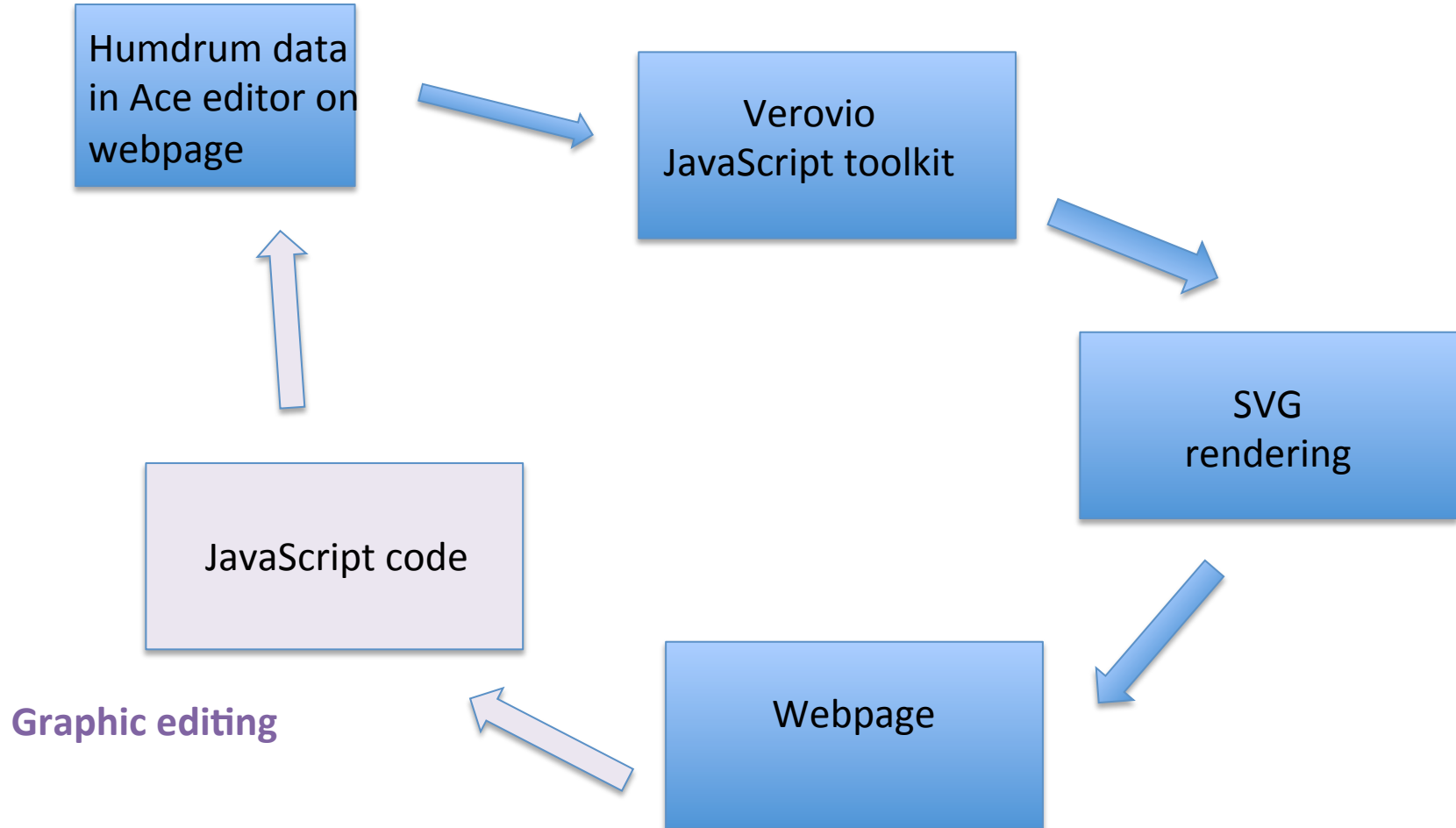
The screenshot shows the Verovio Humdrum Viewer web application. The browser address bar displays verovio.humdrum.org. The application header includes the text "VerovioHumdrumViewer" and a "Play" button. On the left, a list of 27 commands is shown, with the first line highlighted in yellow:

- 1 **kern
- 2 *M4/4
- 3 16eeLL
- 4 16ff
- 5 16ee
- 6 16ffJJ
- 7 16eeLL
- 8 16ff
- 9 16gg
- 10 16ffJJ
- 11 4cc
- 12 8bL
- 13 8gJ
- 14 =
- 15 16eeLL
- 16 16ff
- 17 16ee
- 18 16ffJJ
- 19 16eeLL
- 20 16dd
- 21 16cc
- 22 16bJJ
- 23 8gL
- 24 8aJ
- 25 4e
- 26 ==
- 27 *-

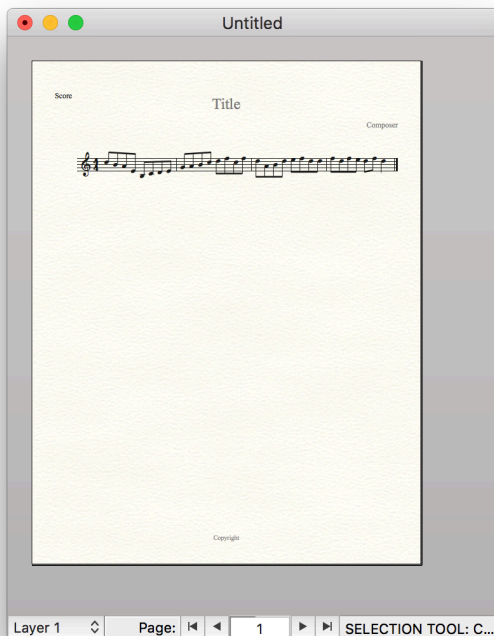
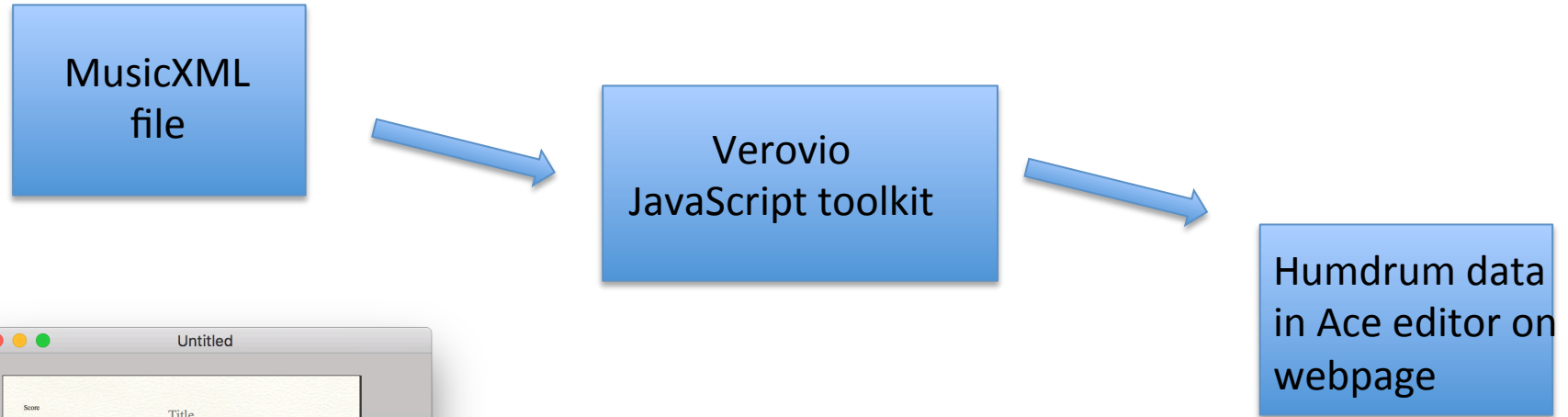
On the right, two staves of musical notation are displayed. The top staff shows a sequence of notes with a slur being added or moved over the third and fourth notes. The bottom staff shows a similar sequence of notes with a slur already present over the first three notes.

- Click on a note
- Type “s” to add a slur to next note
- Type “3s” for 3-note slur
- Left/right arrows move slur start
- Shift-L/R arrows move slur end
- Click on “?” icon for more editing commands

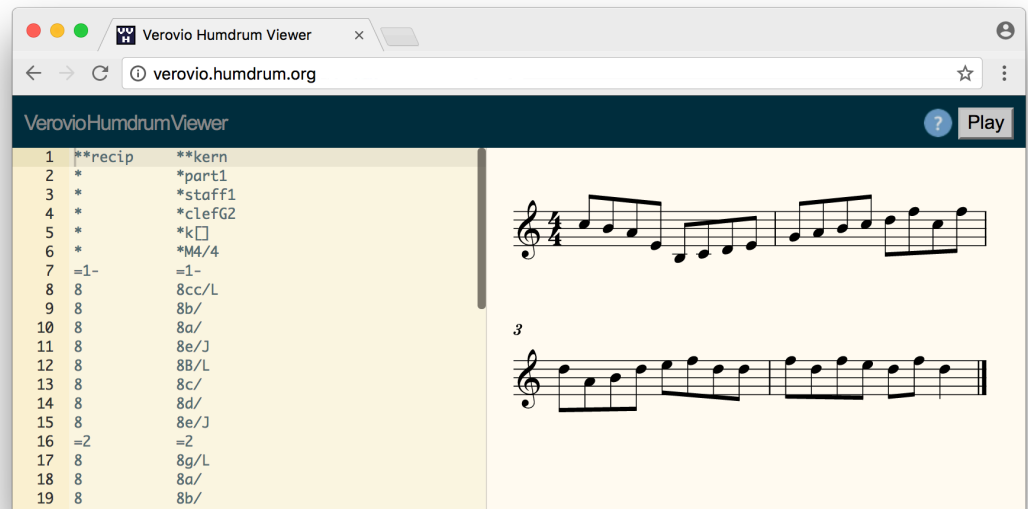
VHV Architecture



MusicXML input



Finale



Export MusicXML, then drag/drop onto VHV page

Repertories on VHV


Verovio Humdrum Viewer

verovio.humdrum.org/?file=beethoven/sonatas/sonata26-3.krn

VerovioHumdrumViewer ◀ ▶ Beethoven, Piano Sonata no. 26 in E ♭ major, op.81a ("les adieux"), mvmt.3

1 !!!COM: Beethoven, Ludwig van
2 !!!CDT: 1770///-1827///
3 !!!OTL: Piano Sonata no. 26 in E-flat major
4 !!!OTP: les adieux
5 !!!ODT: 1809///-1810///
6 !!!ODE: ` l'Archiduc Rodolphe
7 !!!OPS: 81a
8 !!!QMV: 3
9 !!!QMD: Le Retour: Vivacissimamente
10 **kern **kern **dynam
11 *staff2 *staff1 *staff1/2
12 *Ipiano *Ipiano *Ipiano
13 *>[A,B,B1,B,B2,C] *>[A,B,B1,B,B2,C]
14 *>norep[A,B,B2,C] *>norep[A,B,B2,C]
15 *>A *>A *>A
16 *clefG2 *clefG2 *clefG2
17 *k[b-e-a-] *k[b-e-a-] *k[b-e-a-]
18 *E-; *E-; *E-;
19 *M6/8 *M6/8 *M6/8
20 *MM144 *MM144 *MM144
21 =1- =1- =1-
22 8A-' 8d/' 8f' 8a-' 8a-' 8a--'\ 8ddd'\ 8fff'\ 8a-
23 *clefF4 * *
24 16BB-/LL 16B-/LL .
25 16D/ 16An/ .
26 16BB-/ 16B-/ .
27 16D/JJ 16d/JJ .
28 16D\LL 16f\LL .
29 16F\ 16d/ .
30 16D\ 16f/ .
31 16F\ 16a-/ .
32 16D\ 16f/ .
33 16F\JJ 16d/JJ .
34 =2 =2 =2
35 16F\LL 16a-/LL .
36 16A-\ 16f/ .
37 16F\ 16a-/ .
38 16A-\ 16b-/ .
39 16F\ 16a-/ .
40 16A-\JJ 16f/JJ .
41 *clefG2 * *
42 16B-/LL 16b-/LL .
43 16d/ 16a-\ .
44 16B-/ 16b-\ .
45 16d/ 16dd\ .
46 16B-/ 16b-\ .
47 16d/JJ 16a-\JJ .
48 =3 =3 =3
49 16d/LL 16ff\LL .
50 16f/ 16dd\ .
51 16A-/ 16B-/

Le Retour: Vivacissimamente



Reference Scans

alt-p will display PDF of source scan (when available)


Verovio Humdrum Viewer

verovio.humdrum.org/?file=beethoven/sonatas/sonata26-3.krn

VerovioHumdrumViewer ◀ ▶ Beethoven, Piano Sonata no. 26 in E ♭ major, op.81a ("les adieux"), mvmt.3

1 !!!COM: Beethoven, Ludwig van
2 !!!CDT: 1770///-1827///
3 !!!OTL: Piano Sonata no. 26 in E-flat major
4 !!!OTP: les adieux
5 !!!ODT: 1809///-1810///
6 !!!ODE: ` l'Archiduc Rodolphe
7 !!!OPS: 81a
8 !!!OMV: 3
9 !!!QMD: Le Retour: Vivacissimamente
10 **kern **kern **dynam
11 *staff2 *staff1 *staff1/2
12 *Ipiano *Ipiano *Ipiano
13 *[A,B,B1,B,B2,C] *[A,B,B1,B,B2,C]
14 *norep[A,B,B2,C] *norep[A,B,B2,C]
15 *>A *>A *>A
16 *clefG2 *clefG2 *clefG2
17 *k[b-e-a-] *k[b-e-a-] *k[b-e-a-]
18 *E-: *E-: *E-:

Le Retour: Vivacissimamente



data

kern.humdrum.org/data?l=beethoven/sonatas&file=sonata26-3.krn&format=pdf

Vivacissimamente



View MEI data

Press alt-m to view MEI conversion (alt-h to go back to Humdrum)

The screenshot displays the Verovio Humdrum Viewer interface. The left pane shows the MEI data for a file named 'sonata26-3.krn'. The right pane displays the corresponding musical notation, titled 'Le Retour: Vivacissimamente'.

MEI Data (Left Pane):

```
124 <music>
125 <body>
126 <mdiv>
127 <score>
128 <scoreDef xml:id="scoredef-0000001512618208" midi.bpm="144">
129 <staffGrp xml:id="staffgrp-0000000197266636" symbol="brace" barthru="true">
130 <staffDef xml:id="staffdef-0000001590435826" clef.shape="G" clef.line="2" key.sig="3">
131 <staffDef xml:id="staffdef-0000000509213807" clef.shape="G" clef.line="2" key.sig="3">
132 </staffGrp>
133 </scoreDef>
134 <section xml:id="section-0000001156301598">
135 <measure xml:id="measure-L21" n="1">
136 <staff xml:id="staff-L21F2N1" n="1">
137 <layer xml:id="layer-L21F2N1" n="1">
138 <chord xml:id="chord-L22F2" dur="8" stem.dir="down">
139 <note xml:id="note-L22F2S1" oct="5" pname="a">
140 <accid xml:id="accid-L22F2S1" accid.ges="f" />
141 </note>
142 <note xml:id="note-L22F2S2" oct="6" pname="d">
143 <accid xml:id="accid-L22F2S2" accid.ges="n" />
144 </note>
145 <note xml:id="note-L22F2S3" oct="6" pname="f">
146 <accid xml:id="accid-L22F2S3" accid.ges="n" />
147 </note>
148 <note xml:id="note-L22F2S4" oct="6" pname="a">
149 <accid xml:id="accid-L22F2S4" accid.ges="f" />
150 </note>
151 <artic xml:id="artic-L22F2" artic="stacc" />
152 </chord>
153 <beam xml:id="beam-L24F2-L27F2">
154 <note xml:id="note-L24F2" dur="16" oct="3" pname="b" stem.dir="up">
155 <accid xml:id="accid-L24F2" accid.ges="f" />
156 </note>
157 <note xml:id="note-L25F2" dur="16" oct="3" pname="a" stem.dir="up">
158 <accid xml:id="accid-L25F2" accid.ges="n" />
159 </note>
160 <note xml:id="note-L26F2" dur="16" oct="3" pname="b" stem.dir="up">
161 <accid xml:id="accid-L26F2" accid.ges="f" />
162 </note>
163 <note xml:id="note-L27F2" dur="16" oct="4" pname="d" stem.dir="up">
164 <accid xml:id="accid-L27F2" accid.ges="n" />
165 </note>
166 </beam>
167 <beam xml:id="beam-L28F2-L33F2">
168 <note xml:id="note-L28F2" dur="16" oct="4" pname="f" stem.dir="up">
169 <accid xml:id="accid-L28F2" accid.ges="n" />
170 </note>
171 <note xml:id="note-L29F2" dur="16" oct="4" pname="d" stem.dir="up">
172 <accid xml:id="accid-L29F2" accid.ges="n" />
173 </note>
```

Musical Notation (Right Pane):

The musical notation is titled 'Le Retour: Vivacissimamente'. It shows a piano score with two staves. The first staff is a treble clef, and the second staff is a bass clef. The notation includes various musical symbols such as notes, rests, beams, and articulation marks. The tempo is indicated as 'Vivacissimamente'.

Example of critical edition features

Verovio Humdrum Viewer

verovio.humdrum.org/?file=chorales/chor142.krn

Bach, Chorale 142. *Schwing dich auf zu deinem Gott*, BWV 40/6

1 **!!!COM:** Bach, Johann Sebastian
2 **!!!CDT:** 1685/02/21/-1750/07/28/
3 **!!!OTL@DE:** Schwing dich auf zu deinem Gott
4 **!!!SCT:** BWV 40/6
5 **!!!PC#:** 142
6 **!!!AGN:** chorale
7 ****kern** ****kern** ****kern** ****kern**
8 ***ICvox** ***ICvox** ***ICvox** ***ICvox**
9 ***Ibass** ***Itenor** ***Ialto** ***Isoprano**
10 ***I"Bass** ***I"Tenor** ***I"Alto** ***I"Soprano**
11 ***** ***oclefC4** ***oclefC3** ***oclefC1**
12 ***cleff4** ***cleffv2** ***cleffG2** ***cleffG2**
13 ***k[b-]** ***k[b-]** ***k[b-]** ***k[b-]**
14 ***d:** ***d:** ***d:** ***d:**
15 ***M4/4** ***M4/4** ***M4/4** ***M4/4**
16 ***met(c)** ***met(c)** ***met(c)** ***met(c)**
17 ***MM100** ***MM100** ***MM100** ***MM100**
18 **=1-** **=1-** **=1-** **=1-**
19 **4d** **4f** **4a** **4dd**
20 **4c** **4e** **4a** **4a**
21 **4B-** **4f** **4b-** **4dd**
22 **4G** **4g** **4b-** **4ee**
23 **=2** **=2** **=2** **=2**
24 **4A** **4c** **4a** **4ff**

Press “alt-o” to view
“original clefs”

Verovio Humdrum Viewer

verovio.humdrum.org/?file=chorales/chor142.krn

Bach, Chorale 142. *Schwing dich auf zu deinem Gott*, BWV 40/6

1 **!!!COM:** Bach, Johann Sebastian
2 **!!!CDT:** 1685/02/21/-1750/07/28/
3 **!!!OTL@DE:** Schwing dich auf zu deinem Gott
4 **!!!SCT:** BWV 40/6
5 **!!!PC#:** 142
6 **!!!AGN:** chorale
7 ****kern** ****kern** ****kern** ****kern**
8 ***ICvox** ***ICvox** ***ICvox** ***ICvox**
9 ***Ibass** ***Itenor** ***Ialto** ***Isoprano**
10 ***I"Bass** ***I"Tenor** ***I"Alto** ***I"Soprano**
11 ***** ***oclefC4** ***oclefC3** ***oclefC1**
12 ***cleff4** ***cleffv2** ***cleffG2** ***cleffG2**
13 ***k[b-]** ***k[b-]** ***k[b-]** ***k[b-]**
14 ***d:** ***d:** ***d:** ***d:**
15 ***M4/4** ***M4/4** ***M4/4** ***M4/4**
16 ***met(c)** ***met(c)** ***met(c)** ***met(c)**
17 ***MM100** ***MM100** ***MM100** ***MM100**
18 **=1-** **=1-** **=1-** **=1-**
19 **4d** **4f** **4a** **4dd**
20 **4c** **4e** **4a** **4a**
21 **4B-** **4f** **4b-** **4dd**
22 **4G** **4g** **4b-** **4ee**
23 **=2** **=2** **=2** **=2**
24 **4A** **4c** **4a** **4ff**

App(aratus)/Reading

Humdrum:

```
*          *oclefC4 *oclefC3 *oclefC1  
*clefF4    *clefGv2 *clefG2  *clefG2
```

MEI:

```
<app>  
  <lem/>          lem: Lemma (default: don't add original clefs)  
  <rdg label="original_clef">  
    <scoreDef>  
      <staffGrp>  
        <staffDef clef.shape="C" clef.line="1" n="1" />  
        <staffDef clef.shape="C" clef.line="3" n="2" />  
        <staffDef clef.shape="C" clef.line="4" n="3" />  
      </staffGrp>  
    </scoreDef>  
  </rdg>  
</app>
```